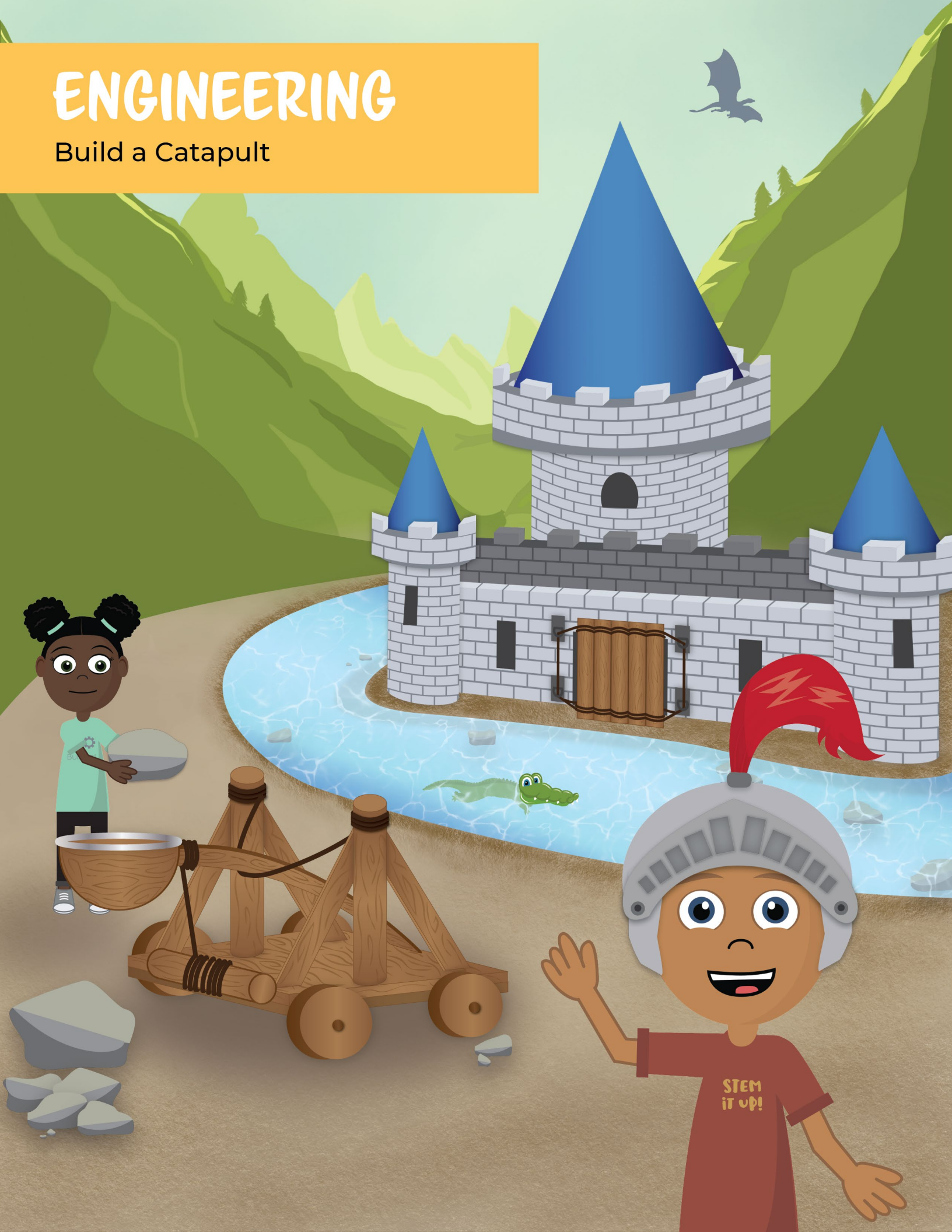
ENGINEERING

Build a Catapult



Building a Catapult

NGSS

4-PS3-3; 5-PS2-1

Objective

The student will understand the engineering process and the interdependence of simple machines within a compound machine.

The student will be able to create a compound machine (catapult) to launch marshmallows the farthest distance possible.

Vocabulary

Simple Machine: The fundamental parts of any machine. Simple machines can exist on their own and are also sometimes hidden in the mechanical devices around you; a device which performs work by increasing or changing the direction of force, making work easier for people to do.

Compound Machine: Consists of two or more simple machines and allows for work to be done more easily.

Structural Engineering: The branch of civil engineering that is responsible for the design of structures.

Background

Compound machines are two or more simple machines interacting with one another to do work. We can find them all around us in everyday items, including a can opener, a pencil sharpener, a wheelbarrow, a pair of scissors, and a piano. Compound machines are dependent on each of its simple machines. If just one of the simple machines in a compound machine is removed, the compound machine may not function as well. Engineers use their knowledge of simple machines to create many of the compound machines we use every day.

Engineering firms do work for people in a variety of ways. A structural engineering firm,

for instance, may at one time help build a skyscraper wherein people can work, then build a bridge that connects people with one another, and yet another time design the devices used in a circus performance to entertain people. A structural engineer is one who designs the structures, or the "built things" around us. Like the buildings towering above us, devices used in entertainment acts must be structurally engineered for, above all, safety. These devices in entertainment include the chains and supports of a swing holding intertwined trapeze artists and the web of metal giving form to a large tent, or “big top”. During this activity, we are going to imagine that we are structural engineers.

To cover the most horizontal distance possible, a projectile should be launched from a 45° angle. Remember this fact, because you will need to apply it to the construction of your catapults in the upcoming activity.

If a projectile is launched from an angle greater than 45°, where will it go? (Answer: It will go higher, but not cover as much horizontal distance.)

If the same projectile is launched from an angle less than 45°, where will it go? (Answer: It will not go as high and therefore is pulled to the ground more quickly by gravitational force, and thus, falls short.)

Materials

Per Group (2-3 students):
The idea here is to provide a variety of useful supplies that allow students to brainstorm and design their own original catapults.
INSTRUCTORS: Construct at least 1-2 sample catapults in advance of the lesson.

For catapults:

- Newspapers
- Popsicle sticks (thick and thin)
- Plastic spoons
- Dixie cups
- Rubber bands (various sizes)
- Soup cans
- Cans of pop
- Bottle caps

- Scissors
- Tape (masking or duct)
- Measuring tape or meter sticks
- Paper & pencil

NOTE: *This is just a sample of potential items to include. Materials can be added or omitted from this list.*

For the Target game:

- Jumbo marshmallows
- Mini marshmallows
- 1-2 decks of cards
- Printouts of targets. (Cut out and taped to empty soda bottles)
- Empty soda bottles
- Material to stack bottles on top of (cereal boxes, shoe boxes, etc.)

Procedure

1. Introduce the topic using background information and thinking prompts/guiding questions.
2. Split students into groups of two (if necessary).
3. Lay out all of the available supplies for building the catapult. Show examples of catapult designs.
4. You can make all materials available to students or incorporate budgeting by adding a price tag to each supply.
5. Have students sketch a rough design for their catapult based on available supplies.
6. Once students have made their preliminary drawing, they can gather or “purchase” their supplies.
7. Allow students time to design, build, test, redesign, rebuild, retest their catapults.
8. Once students are happy with their catapult, move on to Angry Birds competition.
9. Set up one or two target stations (depending on available supplies)
10. Tape targets onto plastic bottles
    a. Build structures using cereal boxes (or any other available supplies) and incorporate the pig bottles.
        i. Students should help build these structures.
    b. Think Angry Birds. If you don’t know what this is, Google it.

11. The deck of cards is used to determine how many marshmallows and which kinds of marshmallows each student can launch.
    a. The student will pull a card from a shuffled deck. (Remove Jacks, Queens, and Kings.)
        i. If the card is an Ace-5, students get the respective number of jumbo marshmallows (note: aces are low and represent 1)
        ii. If the card is a 6-10, students get to use the respective number of mini marshmallows.
        iii. If the card is a Joker, students get to draw two cards and receive the combined number of marshmallows.
    b. The student then gets to use all of their marshmallows as ammunition in their catapult to try to knock all of the pig bottles down to the floor.
        i. If a student does not knock all the pig bottles down to the floor...
            1. Pull two more cards.
            2. Take the difference between the two numbers.
            3. Use that number of mini marshmallows.
12. Students will take turns during the target activity. Shuffle the deck between each student. Replace cards immediately after pulling them out of the deck.
13. Clean up workspaces together.

Differentiation

1. Use budgeting component for building the catapults or place limits on supplies.
2. Change the rules for the target game to increase difficulty.
    a. Change the card/marshmallow rules.
    b. Make a point system for the bottles. For example, if bottles are worth different points, students can keep track of their points after knocking bottles down.

Guiding Questions

- What does a catapult look like? (Discuss where the students get their ideas. Perhaps from a film.)
- Does anyone have an idea of how to build a catapult? Have a student come up and draw a catapult design on the board based off the available supplies.
- Ask the students what simple machines are found in the catapult they are building? (Answer: The arm is a lever and the straw around the dowel forms a wheel and axle.)

Career/Future Application

Simple machines and compound machines are the foundation of many modern conveniences. Engineers use a combination of levers, wedges, screws, wheels and axles, pulleys, and inclined planes to develop simple tools, such as a pencil sharpener, to complex machines, such as an elevator or airplane. Compound machines are everywhere. Engineers usually design machines for a specific function, as specified by their clients. Engineers also must design within certain constraints including time, money, and human resources.

Sources

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